MEMORANDUM

TO: Mayor and Council

FROM: Michael L. Personett, Interim Director
Watershed Protection Department

DATE: March 30, 2018

SUBJECT: Council Resolution No. 20170615-071
Green Stormwater Infrastructure and Green Infrastructure

The purpose of this memorandum is to provide you with two deliverables (attached) as required by Council Resolution No. 20170615-071, one pertaining to Green Stormwater Infrastructure (GSI) and the other to Green Infrastructure (GI).

As defined in the Council Resolution, GSI is:

> *"...a stormwater management practice referring to set of design features in buildings and landscapes that can retain and beneficially re-use rainwater on-site and increase infiltration of rainwater to improve stream baseflows thereby decreasing the amount of run-off that flows off site."*

While often used inter-changeably with GSI, Green Infrastructure (GI) is much more broadly defined in the Imagine Austin Comprehensive Plan as:

> *Green infrastructure is strategically planned and managed networks of natural lands, parks, working landscapes, other open spaces, and green stormwater controls that conserve and enhance ecosystem services and provide associated benefits to human populations.*

The attached report, entitled *Green Stormwater Infrastructure: A Catalog of Projects, Programs, Initiatives and Next Steps* addresses the following elements of the Council Resolution with respect to GSI:

- A history of watershed and GSI regulations in Austin;
- An inventory of GSI projects built by COA and the private sector;
- Summaries of existing policies and programs that incentivize and encourage use of GSI.
- Evaluation of proposed CodeNEXT standards for GSI.

Also attached is a work plan, as required by the Council Resolution, which describes the approach and timeframe for development of an *Integrated Green Infrastructure Plan*. In essence, the framework for development of this plan will address tasks described in Imagine Austin and will ultimately result in a report to Council presenting the results of a gap analysis and GI needs assessment along with recommended solutions.

If you have questions about either of these documents, please feel free to contact the following Watershed Protection Department staff:

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2018 CITY OF AUSTIN GREEN STORMWATER INFRASTRUCTURE:

Catalog of Infrastructure, Initiatives, and Next Steps

Prepared for
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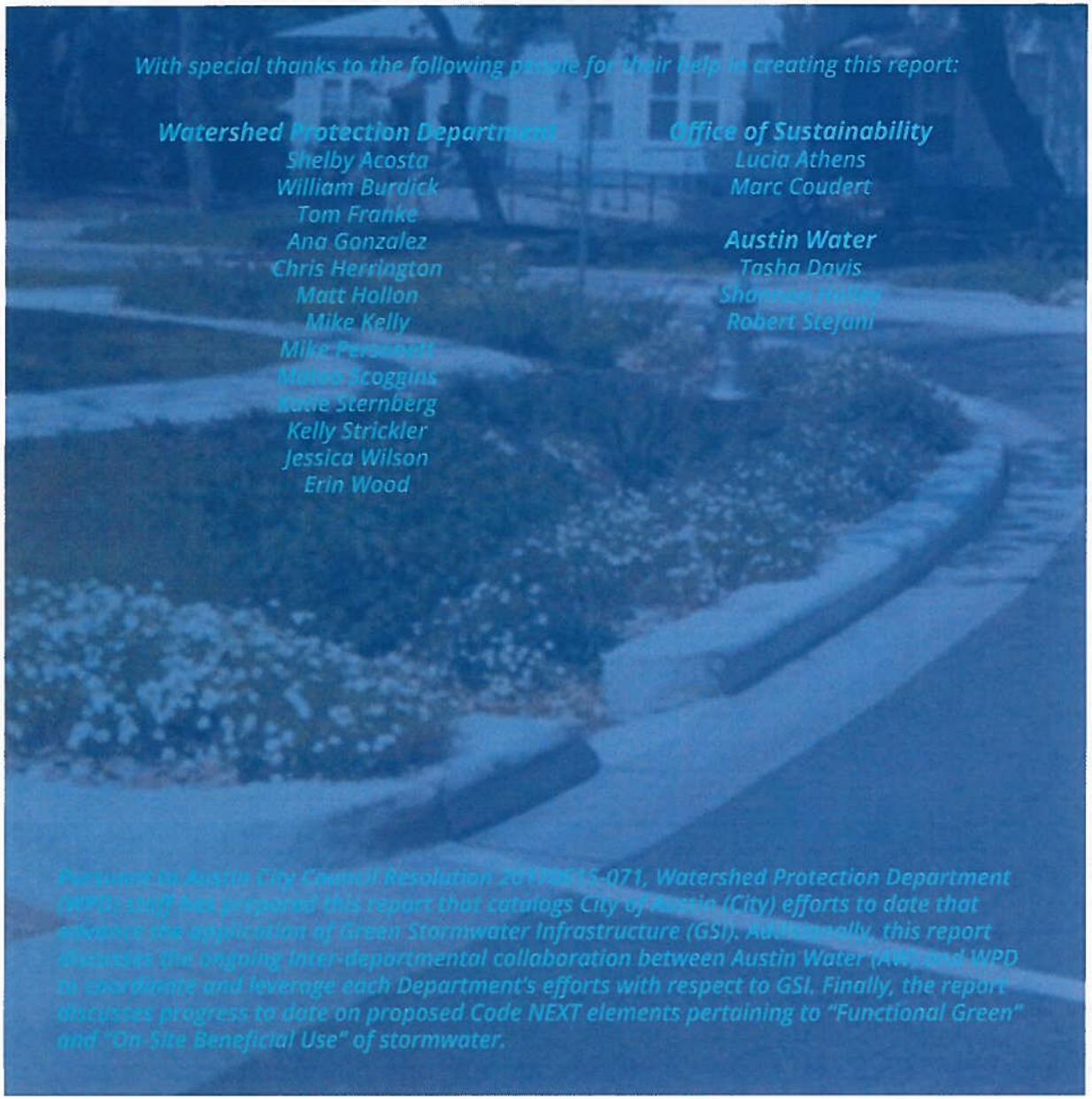
March 2018



With special thanks to the following people for their help in creating this report:

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Pursuant to Austin City Council Resolution 20170615-071, Watershed Protection Department (WPD) staff has prepared this report that catalogs City of Austin (City) efforts to date that advance the application of Green Stormwater Infrastructure (GSI). Additionally, this report discusses the ongoing inter-departmental collaboration between Austin Water (AW) and WPD to coordinate and leverage each Department's efforts with respect to GSI. Finally, the report discusses progress to date on proposed Code NEXT elements pertaining to "Functional Green" and "On-Site Beneficial Use" of stormwater.

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INTRODUCTION

Since the 1970s, the City of Austin has been a national leader in flood risk reduction, water quality protection, and stream restoration. The City's comprehensive approach includes regulations that govern land development, Capital Improvement Program projects, and operating programs, such as ongoing maintenance of drainage infrastructure, floodplain management, and education and outreach. The City's watershed protection policies, programs, and projects have been on the leading edge of the evolution of the science and practice of stormwater management. As described in the City's Watershed Protection Master Plan, the Watershed Protection Department's (WPD) overarching goals are to protect the lives, property, and environment of our community by reducing the impact of flooding, erosion, and water pollution.

Green Stormwater Infrastructure (GSI) and Low Impact Development (LID) have been on Austin's menu of stormwater management tools since the late 1990s. Green Stormwater Infrastructure is defined by the WPD GSI Team as:

Stormwater management practices that use landscape features and engineered systems to mimic natural processes, thereby improving the quantity and quality of runoff.

GSI is contrasted with Green Infrastructure, which Imagine Austin defines as:

Strategically planned and managed networks of natural lands, parks, working landscapes, other open spaces that conserve ecosystems and functions, and provide associated benefits to human populations.

While Austin's approach to stormwater management has progressively incorporated strategies to reduce the impact of urbanization on stormwater runoff, both quantity and quality, it was not until the early 2000s that the City began to incorporate GSI technologies and practices into our watershed protection policies, programs, and projects. Until that time, the standard practices for stormwater quantity and quality had been detention ponds and filtration ponds. The widespread use of these tried-and-true stormwater control measures (SCM), particularly in new development, have reduced flood risks, non-point source pollutant loads, and stream erosion, while also protecting the baseflow of streams most degraded by urbanization.

Wider application of GSI-based SCMs offers another tool in the stormwater management toolbox that can: meet water quality standards; help achieve water conservation goals; integrate into the landscape more seamlessly than grey infrastructure; and provide other community benefits like heat island reduction. Some of the limitations to exclusive and more extensive use of GSI as a stormwater management tool include:

- Limited effectiveness in dealing with large storms or flood reduction;
- Higher cost than grey infrastructure;
- More complex site layout designs; lack of standard maintenance practices; and
- Little data on longevity

This report details the efforts undertaken by the City of Austin since approximately 2000 to evaluate and incorporate GSI technologies and practices into City regulations, capital improvement projects, and operating programs. Each chapter focuses on a distinct element of the overall approach to GSI that has been implemented to date. And while not explicitly addressed in this report, it is worth noting that the City also continues to make advances in monitoring stormwater quality and scientific evaluation of innovative stormwater management methods. Engineering and environmental science underlie the code changes, projects, and programs relating to stormwater management implemented by the City. For more information, visit our publications page at *http://www.austintexas.gov/watershed_protection/publications/default.cfm.*

Chapters in this report include:

- Regulatory Policies - Codes and Criteria
- City of Austin Capital Improvement Program Projects
- City of Austin Programs

CHAPTER 1: REGULATORY POLICY

City ordinances and technical criteria are one way we protect water quality in Austin's creeks, rivers, lakes, and springs, and protect lives and property from flooding and erosion. More than twenty years before the terms "Green Stormwater Infrastructure" or "Low Impact Development" came into common usage, the City of Austin had been regulating and mitigating the impacts of land development on watershed health, principally via the Land Development Code (LDC) and associated technical criteria guidance manuals. The LDC contains the rules that land development projects must follow in order to be legally permitted. Examples of watershed protection ordinance provisions include: stream and sensitive environmental feature *setbacks*; floodplain and *erosion hazard protections*; requirements for *flood* detention and *water quality treatment*; and *impervious cover limits*. These regulations have largely achieved the desired outcomes of minimizing flooding, stream erosion, and water quality problems, primarily in new "greenfield" land development projects.

ORDINANCES

In 1974, the Austin City council adopted the **Waterway Ordinance**, with provisions to maintain the "natural and traditional character" of streams and waterways, while also adopting the City's first flood detention rules to prevent and minimize flooding and drainage problems associated with land development.

In 1980, several watershed ordinances were adopted by City Council. The **Lake Austin Watershed Ordinance** (LAWO) was adopted as the City's first major attempt to address water quality degradation and drinking water protection in the face of increasing urbanization of the Lake Austin Watershed. Key features of the ordinance included impervious cover limits, restrictions on development on steep slopes, cut and fill limits, and construction-phase erosion and sedimentation controls. The **Barton Creek Watershed Ordinance** (BCWO) focused on non-structural water quality controls, including impervious cover limits and stream setbacks. The **Williamson Creek Watershed Ordinance** (WCWO) applied structural water quality control requirements to areas of Williamson Creek contributing recharge to the Barton Springs segment of the Edwards Aquifer.

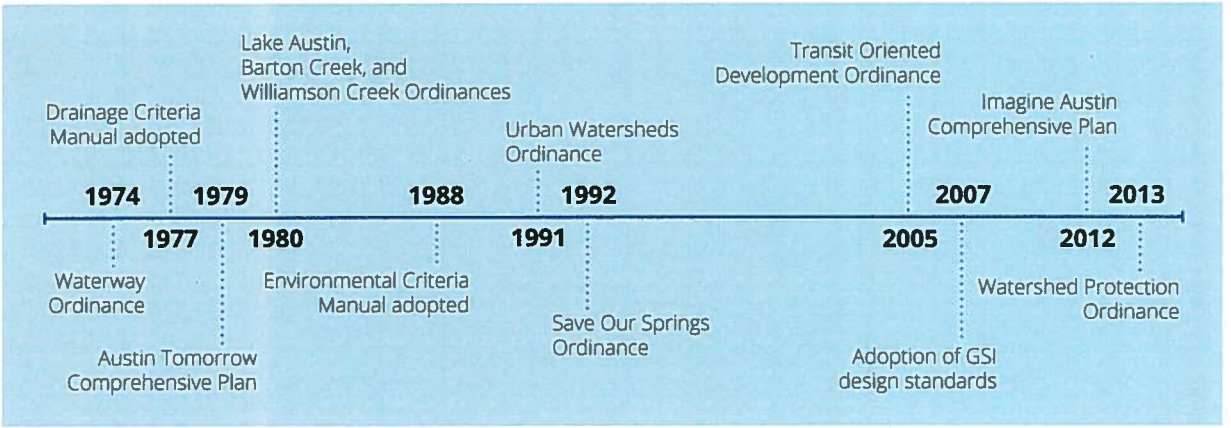


***FIGURE 1** HISTORY OF ORDINANCES*

In 1986, the **Comprehensive Watersheds Ordinance** (CWO) extended water quality protection throughout the City's planning area except the Urban watersheds. The CWO varied the requirements of regulations based on relationships to water supply and the degree of urbanization within a watershed. In addition to stream setbacks, water quality controls, and impervious cover limits, key additions of the ordinance included net site area (limited the percentage of impervious cover by removing sensitive land features from the gross acreage of a development) and critical environmental feature protection.

The **Urban Watersheds Ordinance** (UWO), passed in 1991, extended protection to the Urban watersheds, including water quality controls and stream buffers. The UWO also provided the opportunity for a developer to make a payment into a regional water quality fund rather than provide on-site water quality controls. This funding is used by WPD to retrofit urbanized areas that were developed before water quality regulations.

The first ordinance to explicitly include stormwater controls that are now considered GSI was the **Save Our Springs Ordinance** (SOS), approved by City Council in 1992 after a citizen referendum. In addition to limiting impervious cover in areas providing recharge to the Barton Springs segment of the Edwards Aquifer, SOS required that all developments limit the load of pollutants discharged to pre-development conditions. The primary means of accomplishing this has been with a practice known as "retention-irrigation." Retention-irrigation systems capture a volume of stormwater runoff and then infiltrate and treat that volume via dedicated irrigation fields.

In May 2005, Council passed the **Transit Oriented Development (TOD) Ordinance**, which integrates land use and transportation. As part of the Regulating Plan required for each designated TOD, all commercial development and redevelopment is required to meet 75% of the required water quality volume with GSI.

The most recent significant ordinance to include specific regulatory provisions for GSI is the **Watershed Protection Ordinance** (WPO) adopted in 2013. While primarily focused on extending creek buffers, particularly in eastern watersheds, and improving floodplain protections, the WPO also allows the use of GSI as stormwater quality SCMs within the critical water quality zone (CWQZ). The CWQZ is the buffer area along creeks within which development is limited.

At the present time, for CodeNEXT, the re-write of the City's Land Development Code, City staff are recommending that commercial redevelopment sites be required to use GSI to capture and treat the LDC-required water quality volume (up to 1.3 inches of runoff). Conventional water quality controls (e.g., sand filters) are allowed under certain conditions, including residential subdivisions, hot-spot land uses (e.g., automotive repair), and regional ponds. Sites with greater than 80% impervious cover may also use conventional controls, but would be required to treat a portion of the runoff with GSI. In addition to these new water quality requirements, the landscape code will require that all parking lot medians, islands, and peninsulas be constructed below grade to receive stormwater runoff for treatment and infiltration. Sites with greater than 80% impervious cover will use a new program, referred to as "Functional Green" to comply with landscape requirements. This program will offer credit for GSI features, including rain gardens, rainwater harvesting, and porous pavement.

CRITERIA MANUALS

Criteria manuals are administrative companions to the Land Development Code (LDC) that provide technical guidance on achieving the goals of ordinances. The Environmental Criteria Manual (ECM) is the companion to LDC 25-8 (Environment) and the Drainage Criteria Manual (DCM) accompanies LDC 25-7 (Drainage). The ECM was first introduced in 1988 and the DCM in 1977.

In June of 2007, the City of Austin adopted standards for the design, construction, and maintenance of Green Stormwater Infrastructure to meet the water quality requirements of the Land Development Code (LDC). Prior to 2007, the City allowed certain GSI practices to be used to meet water quality permit requirements on a case by case basis. These practices included biofiltration ponds, vegetated filter strips, and porous pavement.

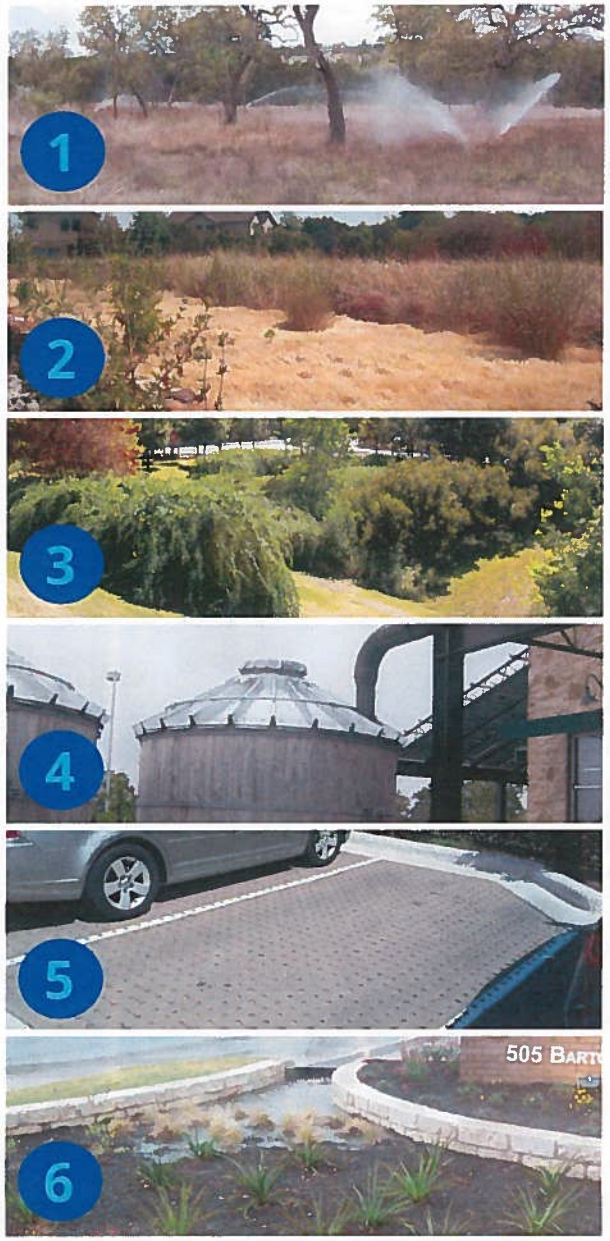
The Land Development Code (25-8-213) requires capture and treatment of a prescribed volume of stormwater runoff by water quality controls for developments, both private and by the City, with greater than 8,000 square feet of impervious cover. The required capture volume is the first one-half inch of runoff plus an additional one-tenth of an inch for each 10 percent increase in impervious cover over 20%. The water quality SCM must provide at least the same treatment level as a sedimentation-filtration system (i.e., a sand filter). Captured runoff may be infiltrated or discharged from controls within 48 to 72 hours in most cases; and longer drawdown times may be permitted with conditions for rainwater harvesting systems. In the Barton Springs Zone, the Save Our Springs (SOS) Ordinance requires the site to provide a non-degradation level of treatment for all development so that pollutants are reduced to the background levels for an undeveloped site. As previously described, this is primarily achieved through the use of retention-irrigation systems.

Prior to incorporation of GSI provisions in the ECM, WPD researched the suite of GSI practices that were available for stormwater control. The ECM was then amended to allow the following practices, with technical guidance, as compliant with provisions of the Land Development Code (LDC 25-8-211, 25-8-213, 25-8-514) for all watersheds, including the Barton Springs Zone. This criteria allows the developer to choose the most appropriate type of stormwater control for the site. The adopted GSI measures included:

1. Retention-Irrigation - Two-phase controls consisting of a retention pond that feeds an irrigation system, distributing the runoff over an infiltration field.
2. Vegetative Filter Strips - Vegetated areas adjacent to impervious cover that receive sheet flow runoff treated by a combination of filtration through dense vegetation and infiltration into the soil.
3. Biofiltration Sedimentation/Filtration - Basins with organic media and vegetation designed to remove more dissolved pollutants than the standard Sedimentation/Filtration SCM using sand as the filtration media.
4. Rainwater Harvesting - Cisterns to capture runoff coupled with a beneficial use such as landscape irrigation or other non-potable water supply use.
5. Porous Pavement - Paving systems for parking lots, sidewalks, and private drives that allow stormwater to infiltrate into a permeable subgrade for infiltration into the sub-soil.
6. Rain Gardens – Generally one or more small-scale shallow, depressed vegetated landscape areas designed to filter and/or infiltrate runoff.

Figure 2 maps the distribution of GSI SCMs permitted since 2005 by the City of Austin to meet water quality regulatory requirements. Over the period since 2005, over 640 separate GSI controls have been constructed to meet City of Austin stormwater permit requirements. These controls treat approximately 3,140 acres of developed land. For comparison purposes, the number of non-GSI stormwater control measures (SCM) for all permitted projects since tracking began is 2,500, treating a combined acreage of 35,500 acres of developed land. Of interest is the number of acres treated per control. GSI controls treat an average (mean) of 1.5 acres, while non-GSI controls treat a mean of 14.1 acres per control—with a median of 3.2 acres per control. This is significant in terms of the amount of land needed to provide controls on site as well as the number of controls needed to treat a given developed area. In addition to the above, GSI is eligible for a variety of regulatory incentives, including:

- GSI is permitted within the outer half of the critical water quality zone in both Urban and Suburban watersheds. Conventional water quality controls such as sand filters are not allowed.
- Planned Unit Developments (PUDs) can demonstrate superiority by using innovative controls to treat at least 25% additional water quality volume and provide 20% greater pollutant removal than code requirements.
- GSI may receive credit for landscape and/or open space requirements. In addition, rain gardens are allowed within zoning compatibility setbacks.
- Commercial developments must direct stormwater runoff to 50% of required landscape areas. Landscaped areas can be designed to achieve water quality credit by integrating green stormwater infrastructure.
- Sites that cannot meet strict compliance with Landscape Criteria can meet their requirements by incorporating GSI into the landscaped areas.



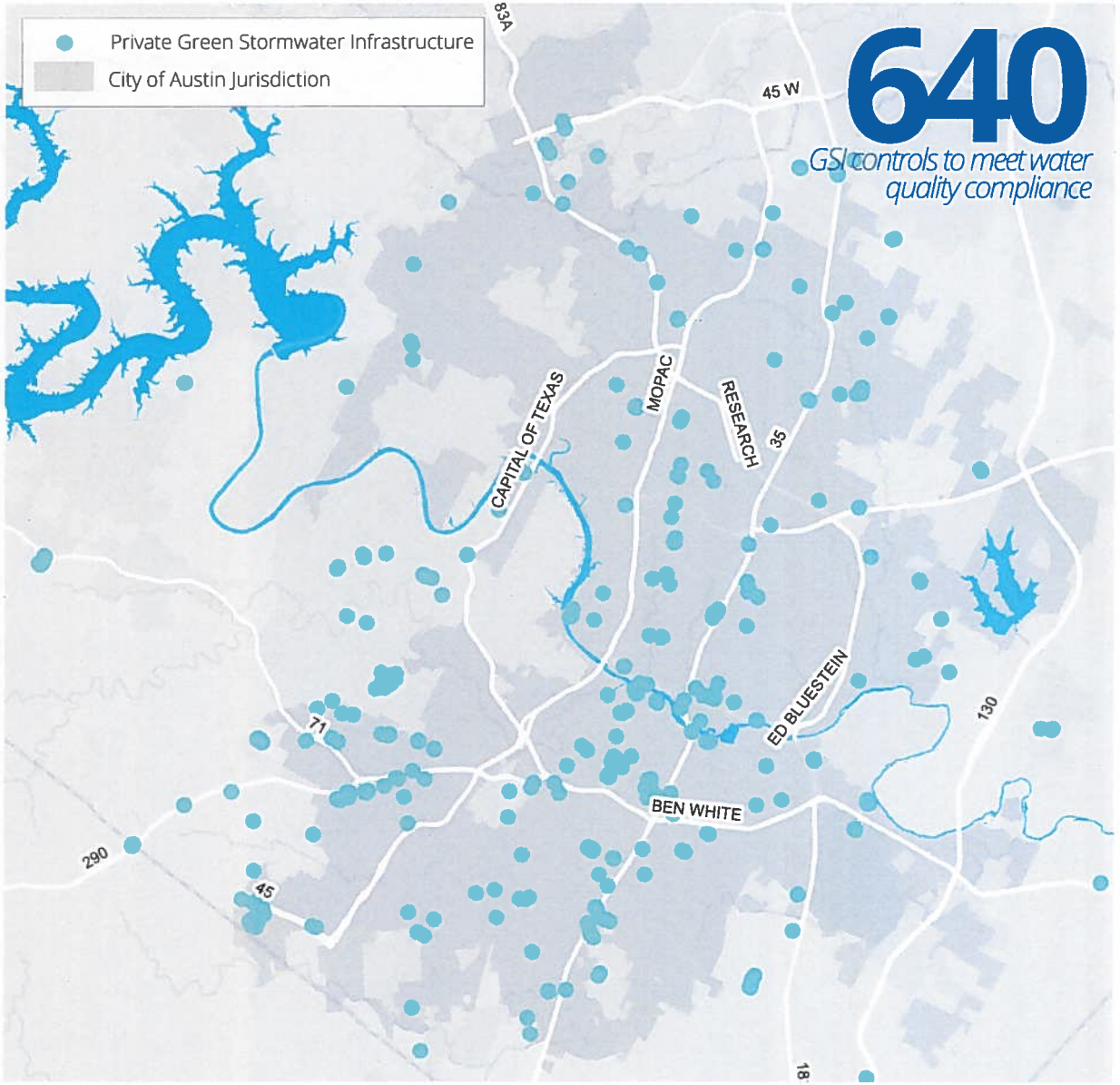


FIGURE 2 *GREEN STORMWATER INFRASTRUCTURE BUILT FOR CITY OF AUSTIN PERMIT COMPLIANCE*

CHAPTER 2: CITY OF AUSTIN-SPONSORED GSI PROJECTS

The City of Austin, through Capital Improvement Program projects and utility maintenance projects, has designed, constructed, and maintains an array of GSI. Figure 3 maps those GSI projects constructed and maintained by the City of Austin.

To date the City has constructed 99 GSI facilities treating a drainage area of 942 acres of developed land. The public GSI projects treat specific City facilities, City right-of-way, and in the case of regional stormwater retrofits, all public and private land that drains to a given facility.

The City of Austin GSI projects have been built by several departments including Watershed Protection, Public Works, Austin Transportation, and Parks and Recreation. They are the result of stand-alone projects designed to retrofit urban areas developed prior to regulations requiring SCMs and other facility and utility development seeking to add additional benefits to the project. The following sections will explore the drivers for these two primary types of public GSI projects.

WPD RETROFITS

Since GSI aligns most closely with the Watershed Protection Department's (WPD) missions and goals for stream restoration (i.e., erosion control) and water quality protection and restoration, WPD has been the lead department and champion for a majority of publicly-funded GSI projects. WPD funds GSI projects from the Drainage Utility Fund and from the Urban Structural Control funds (water quality payment-in-lieu deposits) to build GSI water quality controls in areas of the city that were built before water quality regulations required on-site controls. These controls are typically built on public land and range from regional retrofits greater than 10 acres to individual City facilities and roadway rights-of-way that drain less than one acre.

Examples of WPD GSI projects include:

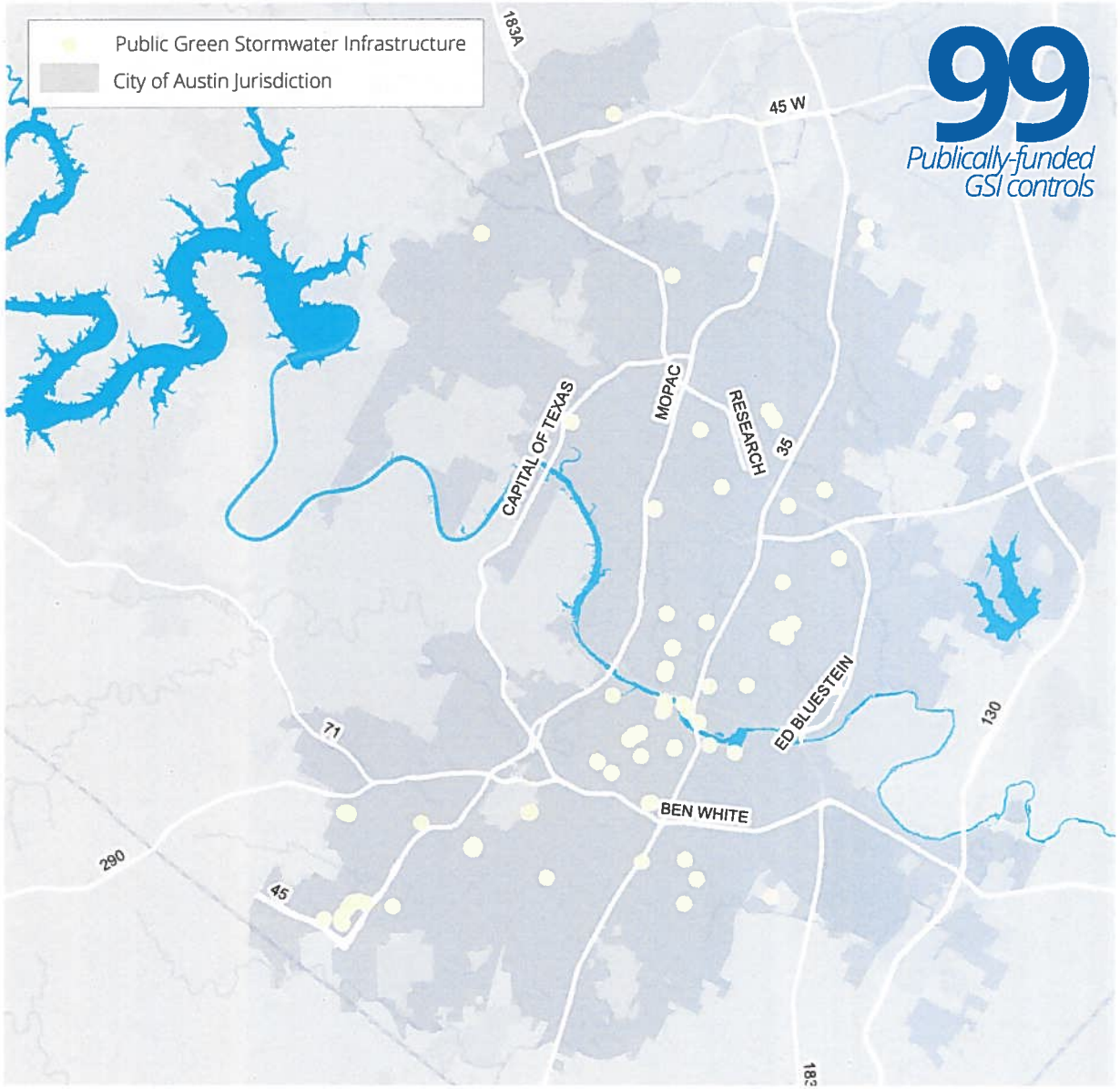


FIGURE 3 *PUBLICLY FUNDED AND MAINTAINED GREEN STORMWATER INFRASTRUCTURE*

FIGURE 4 *PUBLICLY FUNDED AND MAINTAINED GREEN STORMWATER INFRASTRUCTURE*

Sand Beach Biofiltration Pond. This facility at the intersection of North Lamar and Cesar Chavez Boulevard was constructed in 2006 in conjunction with the development adjacent to the site. It treats seven acres of private land and City right-of-way, removing 7,300 lbs. of pollution per year at a cost effectiveness of $0.37/lb. of pollution removed.

One Texas Center Rain Gardens. Two rain gardens treat the front of this City facility at the intersection of South First Street and Barton Springs Road. They treat one acre of land, removing 1,580 lbs of pollution per year at a cost of $9.13/lb. of pollution removed. This project was funded by the Urban Structural Control Fund, which uses payments made by developers in lieu of constructing on-site water quality controls in Urban watersheds.

COUNCIL RESOLUTIONS

Council Resolutions that direct staff to integrate GSI into City projects are the primary drivers for departments outside of WPD to include GSI in their capital and maintenance projects. In November 2007, City Council passed a resolution (CR 20071129-046) requiring City buildings and associated site development to maximize opportunities to include GSI to meet water quality requirements. The projects that incorporated GSI into the plans are a subset of the public projects, but are not specifically called out in the map in Figure 3. Examples include:

Vic Mathias Park at Auditorium Shores. The park improvements included a trailhead, deck overlook, new restroom, and parking lot upgrades. The project included biofiltration ponds and rain gardens to meet water quality requirements.

Twin Oaks Library. Completed in 2010, this 10,000 square foot library implemented rainwater harvesting systems, rain gardens, and a biofiltration pond to meet water quality requirements. In 2014, the Texas water Development Board awarded the project its Texas Rain Catcher Award in recognition of exemplary efforts to promote rainwater harvesting and water conservation through educational and outreach activities.

In June 2014, Council passed the Complete Streets Policy in resolution (CR 20140612-119). The term "Green Streets" is specifically called out in the resolution as an integral part of Complete Streets. A Green Street is a public street right-of-way that is context-sensitive and that incorporates landscape features, engineered stormwater controls, and sustainability principles in the design, operation, and maintenance of the right-of-way. Examples of GSI projects built by the City in the context of the Complete Streets Policy include:

Todd Lane Roadway Improvements. This Public Works/ Austin Transportation Department Capital Improvement Program (CIP) project expanded Todd Lane from two lanes to four lanes. A combination of seven rain gardens and two biofiltration ponds treated eight acres of City right-of-way.

Davis Lane Intersection Improvements. This Public Works/ Austin Transportation Department CIP project improved traffic flow, added bike lanes, and provides water quality treatment for 0.4 acres of drainage with the rain garden shown in Figure 4.

CHAPTER 3: CITY OF AUSTIN GSI PROGRAMS

In addition to regulations and construction projects that implement GSI measures, the City of Austin has developed programs that evaluate GSI and encourage other agencies and individuals to implement on-site GSI measures. Austin Water and Watershed Protection are the sponsors of the following GSI programs. Each of these programs are described below.

- Austin Water (AW) Rainwater Harvesting and Waterwise Rainscapes
- WPD Education Outreach
- WPD GSI Team
- WPD Stormwater Management Discount
- WPD Rain Catchers
- AW Water Forward Task Force
- CodeNEXT – Green Stormwater Infrastructure Proposal

AUSTIN WATER RAINWATER HARVESTING REBATE PROGRAM

Since 1999, the City of Austin has been implementing small-scale GSI programs, starting with Austin Water's Rainwater Harvesting Rebate Program. Initiated as a water conservation strategy to reduce the use of potable water for outdoor irrigation, the program also doubled as a small-scale approach for homeowners and businesses to manage stormwater runoff. By providing incentives in the form of rebates, the program makes a direct impact on potable water use and stormwater and it also creates an awareness of the relationship between rainwater, stormwater, and water use. This increased awareness is key to larger scale adoption of lot-based GSI.

The first rainwater harvesting rebate program consisted of a $30 rebate for purchasing approved rain barrels and a rebate of up to $500 for larger systems, depending on the storage capacity and cost of the system. Unfortunately, at that time there were few local suppliers of rain barrels. In the first year of the program, the Water Conservation Division (WCD) issued rebates for 18 rain barrels at approximately 55 gallons each and an additional nine rebates for larger rainwater systems. The total volume rebated for the fiscal year 1998-99 was 12,990 gallons.

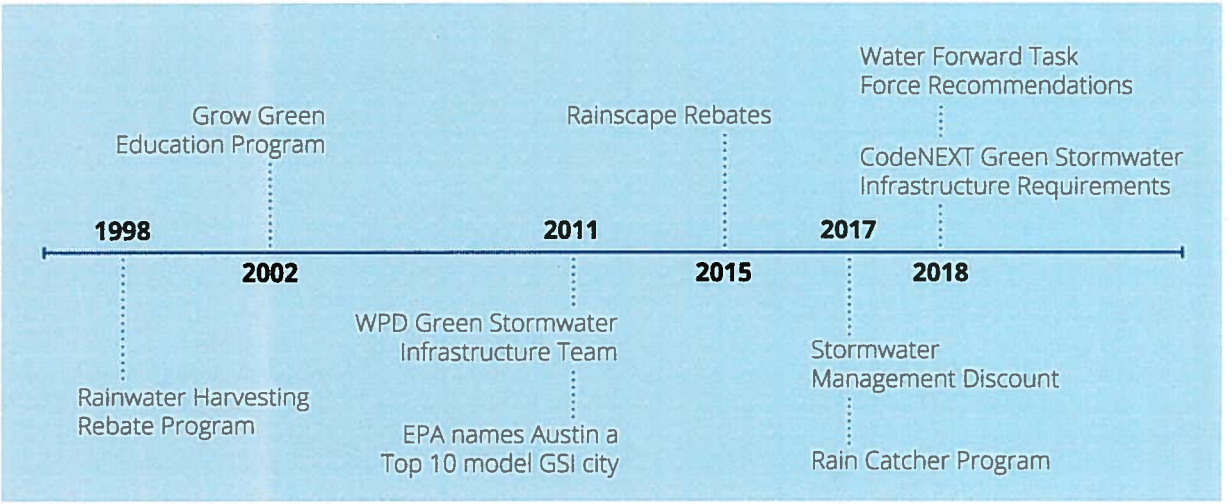


***FIGURE 5** SIGNIFICANT PROGRAMS*

In April 2001, Austin Water decided to supply barrels to its customers at a subsidized price, in addition to offering rebates. For the first year of the rain barrel program, the City purchased 1,000, 75-gallon barrels and sold them to customers at $20 each, limited to one per residential account. All 1,000 barrels were sold within eight hours. The City continued to sell rain barrels at a subsidized price for a total of nine years, from fiscal year 2000-2001 through fiscal year 2008-2009.

The rainwater rebate and rain barrel distribution programs appear to be an effective marketing tool. The popularity of the program has spurred interest in larger rainwater systems and increased the availability of rain barrels and cisterns at local suppliers. Though the City no longer sells rain barrels, the rainwater harvesting rebate program continues. The current program allows applicants to receive $0.50 per gallon of capacity for gravity fed systems, or $1 per gallon of capacity for pressurized systems – up to 50% of the cost of the system. Austin Water customers can apply once per year for additional capacity (system expansions), until they reach the lifetime limit of $5,000 per address.

Rebate participation remained relatively steady until 2011. From October 2010 until September 2011, rainfall averaged just over 11 inches, making it one of the driest years in recent Central Texas history. City drought restrictions reached Stage 2, and automatic irrigation was limited to once per week. Rebate participation began to rise at this time, peaking in fiscal year 2013-2014 at 461 rebates, for a total of 369,243 gallons that year. Since fiscal year 2013-2014, rebate participation has been declining steadily. Fiscal year 2016-2017 saw 209 rebates for a total of 143,087 gallons. Total rainwater harvesting gallons rebated (including barrels sold) from program inception though fiscal year 2016-2017 is 2,735,664. Figure 6 shows cumulative rainwater harvesting gallons captured by the program from inception to date.

FIGURE 6 *CUMULATIVE GALLONS REBATED AND SOLD FOR AUSTIN WATER RAIN BARREL PROGRAM*

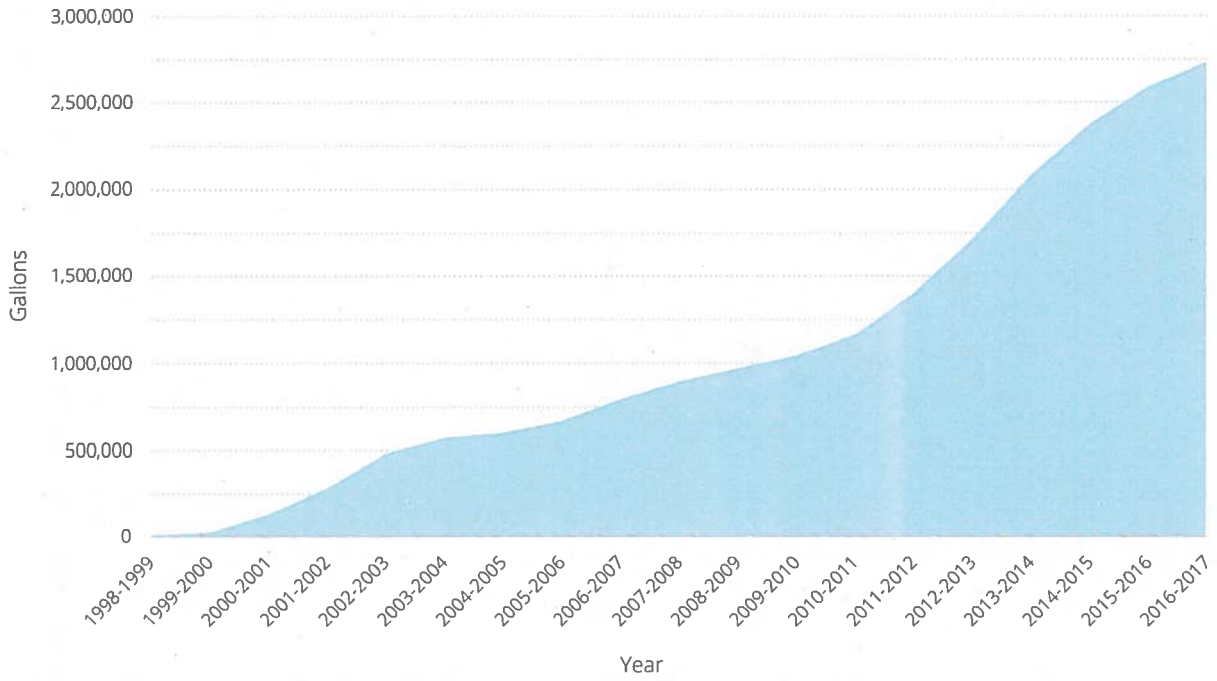


FIGURE 7 *CISTERN WITH A VOLUME OF APPROXIMATELY 2,500 GALLONS (LEFT) AND RAINSCAPE RAIN GARDEN (RIGHT)*

AUSTIN WATER WATERWISE RAINSCAPE REBATE PROGRAM (RAIN GARDENS)

A rebate for the construction of landscape features to retain rainwater on-site (usually referred to as a "rain garden"), was developed by Austin Water in conjunction with Watershed Protection in June of 2015. Landscape features such as berms, terraces, swales, rain gardens, and porous pavement, which function to slow or retain rainwater on the property will qualify. The rebate consists of $0.30 for every square foot of converted lawn (100 square foot minimum), up to $500 per property (lifetime cap). The rebate is limited to residential customers and schools, due to potential conflicts with commercial landscape requirements.

The program was designed to encourage the use of landscape features to prevent runoff and reduce or eliminate the need for supplemental potable water for irrigation. The potential benefits of both water conservation and improved water quality spurred the collaborative efforts of Austin Water and Watershed Protection in designing the program. Since program inception, there have been twelve applicants, seven successful rebates issued, and a total of 1,863 square feet of qualifying area (see Table 1). Of the seven successful rebates, six were single family applicants, and one applicant was an Austin Independent School District (AISD) school.

TABLE 1 *RAINSCAPE REBATES SINCE INCEPTION*

Fiscal Year	Rainscape Rebates Issued	Total Square Feet
2014 - 2015	1	457
2015 - 2016	2	494
2016 - 2017	4	912
Total	7	1863

WATERSHED PROTECTION EDUCATION AND OUTREACH PROGRAM

Community members play a key role in implementing and promoting GSI throughout Austin. Since 2002, WPD's Grow Green Program has promoted sustainable landscape practices to landscape professionals, homeowners, and community groups. Grow Green began specifically targeting GSI to homeowners in 2011 with the release of a homeowner's guide to rain garden installation (see Figure 8 below). Since that time the program has reached over 3,000 local professionals and home gardeners.

Other City of Austin programs specifically target our educational partners who wish to promote and implement GSI features. The Office of Sustainability's **Bright Green Futures Grant program** encourages GSI installation with AISD schools by partnering with WPD to provide funding for projects that capture and use rainwater on campus. To date, more than 31 projects have been funded through this program.

Via the **Cities Connecting Children to Nature** program, the Parks and Recreation Department collaborates with WPD and AISD campuses to install cisterns and rain gardens. Barrington Elementary School was the first designee as a Green School Park under this partnership.

The University of Texas School of Engineering offers a Civil Engineering design class that provides opportunities for students to collaborate with Watershed Protection design staff. The collaborative projects focus on designs of rain gardens and cisterns for AISD campuses. To date, the collaboration has provided designs to 14 campuses and six of those campuses have implemented the plans in partnership with the local chapter of the Environmental and Water Resources Institute. These projects help inspire other campuses to create their own rain gardens and rainwater harvesting systems.

WPD began tracking the number of GSI measures constructed voluntarily by schools, groups, and individuals in 2013. Figure 11 shows the distribution of voluntary GSI projects submitted to WPD.


grow green

earth-wise guide to

Rain Gardens

Keeping Water on the Land

what is a rain garden?

how does a rain garden help?

Create A Rain Garden In Six Steps

1 Find the Right Location

growgreen.org

FIGURE 8 *GROW GREEN RAIN GARDEN GUIDE*

FIGURE 9 *BRIGHT GREEN FUTURE GRANT RECIPIENTS*

FIGURE 10 *GSI INSTALLATION AT JORDAN ELEMENTARY*

WATERSHED PROTECTION GSI TEAM

Faced with a growing need to systematically incorporate GSI into its stormwater management toolbox, Watershed Protection formed the **Green Stormwater Infrastructure Team** in 2011. The team was composed of discipline experts from within WPD with experience in water quality, flood and erosion control, policy/planning, education/outreach, and maintenance. The mission of the team was to explore and advance the application of GSI to stormwater management in Austin. To that end, the team established four objectives:

1. Create a common body of knowledge regarding Green Infrastructure technology, regulations, maintenance, and community acceptance for WPD and City of Austin.
2. Identify opportunities for the application of green infrastructure in City of Austin-sponsored retrofits, private development, and voluntary homeowner projects
3. Identify implementation and long-term maintenance constraints
4. Create delivery plans for Capital Improvement Program projects, regulatory changes, maintenance protocol, and public outreach

Over the course of three years, the GSI team achieved its objectives. A short summary follows.

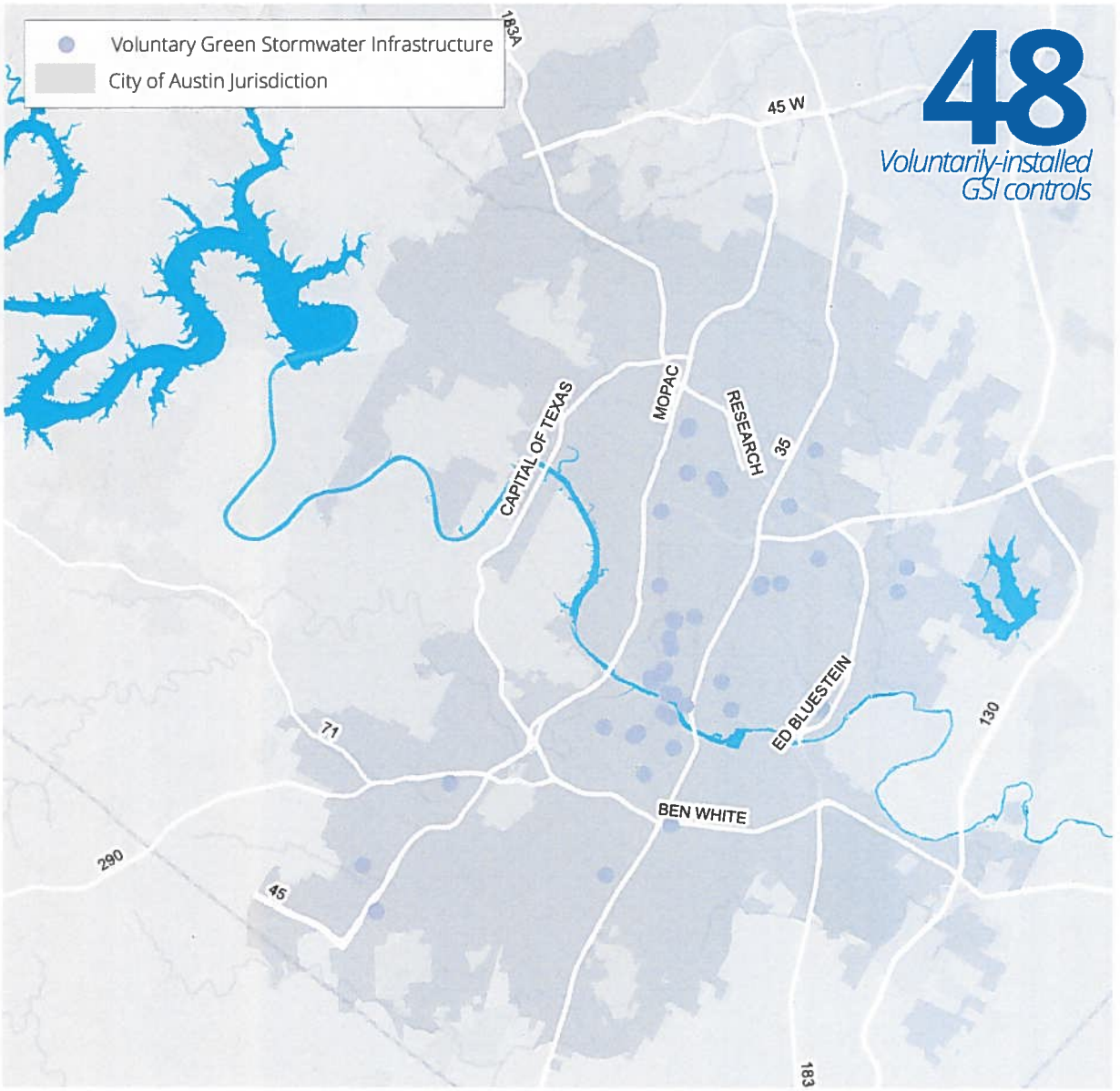


FIGURE 11 *GSI INSTALLED BY COMMUNITY MEMBERS, INCLUDING BRIGHT GREEN FUTURE SCHOOL CAMPUSES*

Objective #1: Create a common body of knowledge regarding green stormwater infrastructure technology, regulations, and community acceptance for WPD and City of Austin.

The team used field trips, literature searches, pilot projects, computer models, stakeholder meetings, and educational programs to identify the most common GSI practices and to understand the physical processes that govern them. As a result WPD staff became educated on the current state of the science for GSI and determined that community stakeholders desired increased ability to use GSI. This stakeholder input formed the basis for Phase 2 of the Watershed Protection Ordinance, which would then evolve into input for the CodeNEXT provisions of on-site beneficial use of stormwater.

Objective #2: Identify opportunities for the application of green stormwater infrastructure in City of Austin-sponsored retrofits, private development and voluntary homeowner projects.

To comprehend the scope of benefits that GSI could provide to WPD missions of flood, erosion and water quality, the team undertook an extensive computer modeling and monitoring project in the Brentwood neighborhood in north-central Austin. This study examined the ability of large-scale (400 acre basin) applications of GSI to reduce flooding, stream erosion, and non-point source pollution. The computer simulation blanketed the primarily single family and commercial land use watershed with rain gardens, rain water cisterns, and soil amendments on residential lots; biodetention ponds in streets; and porous pavement and green roofs on commercial lots. See Figure 12.

Figures 13 and 14 depict the extent of flooding before and after application of GSI with several strategic upgrades to storm drains. The graphics demonstrate that the combined used of extensive GSI and selective storm drain upgrades can virtually eliminate lot and street flooding up to the 10-year storm event. While benefits also accrue for storms larger than the 10-year storm, street and structure flooding still exist. This reduction in flooding is achieved primarily through runoff volume reduction and flow detention in the various GSI components. Additionally,

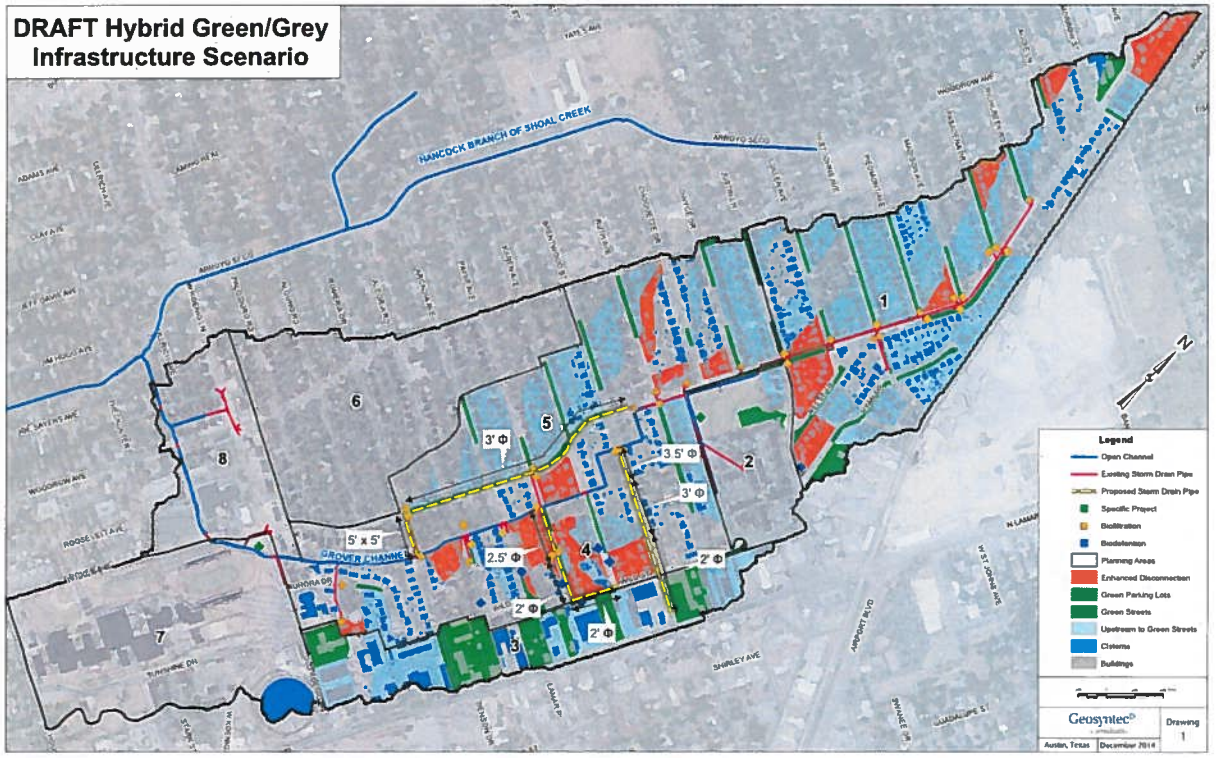


FIGURE 12 *HYBRID GREEN-GREY INFRASTRUCTURE SCENARIO*

the lower runoff volume resulted in a pollutant load reduction of 50,000 lbs per year, while also reducing the in-stream flows that exacerbate stream channel erosion.

This exercise quantified the watershed benefits and also provided cost estimates to achieve these projected results. Fully outfitting this 400 acre watershed with GSI and other improvements is anticipated to cost $15 - 20 million. It is useful to put this cost into perspective to determine the feasibility of moving forward with implementation of the proposal. A previous study indicated that it would cost approximately $200 million to solve all the drainage problems up to a 100-year storm service level. GSI would proportionately solve 10-year storm problems for one-tenth of the cost. And $20 million would be a substantial sum to expend in one neighborhood while still not solving flooding problems for storms larger than a 10-year event. Thus implementation of the large-scale GSI project in Brentwood was not pursued as a cost-effective means of spending limited Drainage Utility funds.

This study, however, was the impetus for a larger study to determine a solution that incorporates more traditional "grey" infrastructure (detention ponds, channel improvements, storm drain upgrades) with GSI to find an optimal solution that provides a more significant improvement in level of service than GSI alone for less money than the full $200 million needed for a complete "grey" solution. That study is on-going.

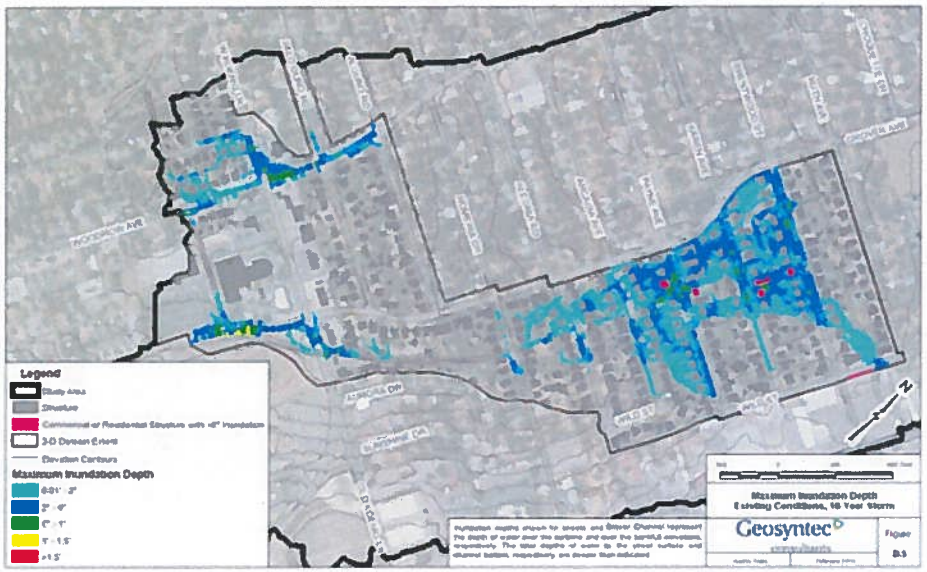


FIGURE 13
EXTENT OF FLOODING FOR A 10-YEAR STORM IN BRENTWOOD UNDER EXISTING CONDITIONS

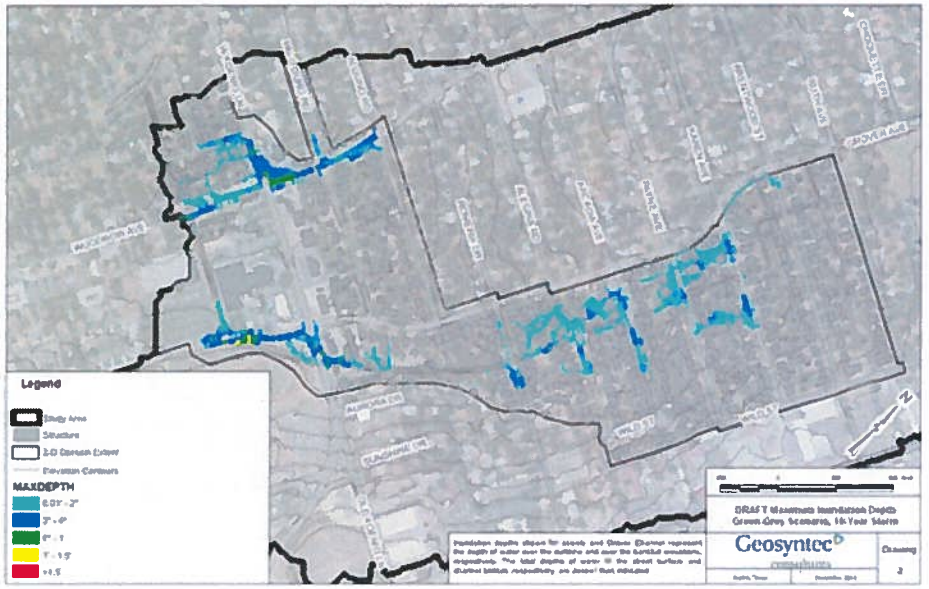


FIGURE 14
EXTENT OF FLOODING FOR A 10-YEAR STORM AFTER APPLICATION OF GSI AND NOMINAL STORM DRAIN UPGRADES

Objective #3: Identify implementation and long-term maintenance constraints.

Through our studies and implementation of pilot programs, WPD discovered that there are limitations to larger-scale adoption of GSI.

- Due to the small capture volume of GSI, even on a distributed basis, it is difficult to provide flood reduction benefits beyond the 10-year storm using GSI alone.
- From a water quality retrofit perspective, GSI is more expensive than larger regional water quality retrofit measures as traditionally applied by WPD. Typical large regional controls result in a cost-effectiveness of < $3/lb of pollution removed, while small-scale GSI costs >$12/lb of pollution removed.
- Regarding maintenance, GSI requires more frequent maintenance than larger regional controls, because small obstructions can cause system bypass. There is little nationwide experience with long-term maintenance of small-scale GSI, and thus there are concerns about its function as a utility asset. Evaluation of the maintenance needs and impacts of failure of regional versus GSI controls at a citywide scale over time is still needed.
- Large-scale adoption of GSI on private residences, especially for regulatory compliance, would cause inspection and long-term tracking challenges not present with larger controls built on separate lots within drainage easements.

Objective #4: Create delivery plans for Capital Improvement Program projects, regulatory changes, maintenance protocol and public outreach.

Based on the results of Objectives 1 - 3, the GSI team recommended the following course for WPD to pursue regarding implementation of GSI:

- A large-scale GSI Capital Improvement Program project for flood reduction is not recommended
- Continue with implementation of small-scale Riparian Restoration Projects that employ low tech, passive, non-engineered GSI solutions
- Explore cost-effective incentive programs that may dovetail with Austin Water's Rainwater Harvesting rebate program (see next chapter on Rain Catchers)
- Continue Green Streets Partnerships. Leverage Austin Transportation and Public Works departments' traffic calming and street reconstruction projects to provide cost effective opportunities to build GSI retrofits in the right-of-way
- Establish maintenance capabilities for small-scale GSI and create a GSI maintenance manual
- Continue to cultivate our educational and outreach partnership programs to encourage voluntary adoption of GSI practices (Neighborhood Partnering Program, UTCE171, Grow Green homeowner guides, Bright Green Futures, mapping small-scale voluntary GSI, brokering pro bono design assistance between consultants and community groups)

From a regulatory perspective, the GSI Team recommended, and WPD implemented, changes to the Land Development Code and Environmental Criteria Manual under the mantle of the Watershed Protection Ordinance of 2013. The key changes included:

- Increased water quality credits for porous pavers to include parking lots; provided allowance for detention storage underneath pavement
- Allowed combining water quality and detention storage in stormwater control measures, especially rain gardens
- Allowed GSI controls in upper half of critical water quality zone in the Desired Development Zone
- Allowed GSI controls in compatibility setbacks
- Allowed rain gardens on single-family development with conditions (ROW access, 4 lots/rain garden, infill with no infrastructure)
- Updated ECM 1.6.9 (SOS compliance) to provide calculator for GSI in Barton Springs Zone

In December of 2014, Watershed Protection officially sunsetted the GSI team and began to incorporate its recommendations into our strategic planning.

STORMWATER MANAGEMENT DISCOUNT PROGRAM

In August of 2017, the Watershed Protection Department launched a program to reward voluntary adoption of GSI and other stormwater control measures (SCMs) by discounting the monthly Drainage Charge paid by residential and commercial property owners. Austin citizens and businesses that voluntarily install stormwater control measures (SCMs) on their property can apply for a reduction to their monthly drainage utility bill, based upon the amount of impervious cover that is offset by features like: rainwater harvesting systems, rain gardens, green roofs, and other detention systems.

The discount is based upon a simple formula that considers the amount of impervious cover and the volume of the SCM that treats the runoff from that impervious cover. Table 2 shows typical discount amounts for various SCMs.

FIGURE 15 *STORMWATER MANAGEMENT DISCOUNT GUIDANCE MANUAL*

TABLE 2 *TYPICAL DISCOUNT AMOUNTS FOR VARIOUS STORMWATER CONTROL MEASURES*

Stormwater Control Measure	*Typical Discount Range*
55 gallon tank	$0.20 to $0.30 per month
Small rain garden (60 sq. ft., 6 in. deep)	$0.70 - $1.20 per month
1,000 gallon tank	$2.90 to $4.90 per month

Actual discount will vary depending on the amount and percent of impervious cover on a property. The low end of the range is based on a property with 2,000 square feet and 30% impervious cover. The high end is based on a property with 5,000 square feet and 50% impervious cover.

WPD RAIN CATCHER PROGRAM: TOWARD AN INTEGRATED PLAN

In 2017, WPD launched the Rain Catcher Pilot Program as a comprehensive effort to integrate and leverage the City's existing GSI programs and resources. Rain Catcher incorporates existing Watershed Protection and Austin Water discounts, rebates, capital funding, and educational & outreach programs with the goal of increasing the prevalence of cisterns and rain gardens that achieve both stormwater management and water conservation objectives.

Modeling simulations indicate that WPD can achieve quantifiable improvements (see Figure 16) in the hydrology and aquatic life of our streams by capturing rainfall and infiltrating into the ground using small-scale, decentralized stormwater control measures (i.e., rainwater harvesting cisterns and rain gardens).

The pilot program is a step-wise effort to work with a small segment of the community to test the hypothesis that greater financial incentives and technical guidance to homeowners and businesses will result in greater adoption of large volume (2,500 gallons) cisterns and rain gardens. The pilot watershed is the upper portion of Waller Creek (see Figure 18).

Between 2017 and 2022, an extensive combination of demonstration projects (public land), residential and commercial systems (private land), and riparian restoration is planned throughout the Upper Waller catchment in an effort to develop the capacity to build distributed SCMs and to evaluate the effect this effort has on the community and the watershed. There will be approximately 10 public property demonstration projects, mostly rain gardens in right-of-ways, but also an extensive installation at Reilly Elementary School, with 10 large cisterns and six rain gardens.

On private property, Watershed Protection is collaborating with the Austin Water Rainwater Harvesting and Rainscape Rebate programs to install rain water harvesting systems and rain gardens that capture 1.3 inches of rain on as many of the approximately 1,200 homes in the catchment as is possible, with a base level goal of 25% (300 homes) by the end of the five year pilot study. This will be kicked off with a block-scale test

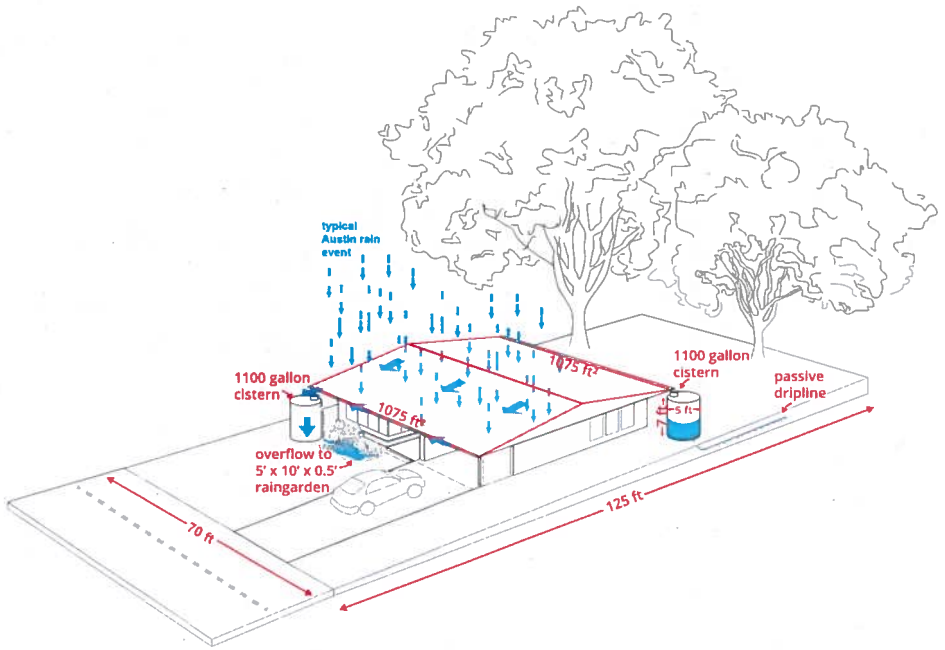


FIGURE 17 *TYPICAL RESIDENTIAL RAIN CATCHER SYSTEM, INCLUDING TWO CISTERNS AND A RAIN GARDEN*

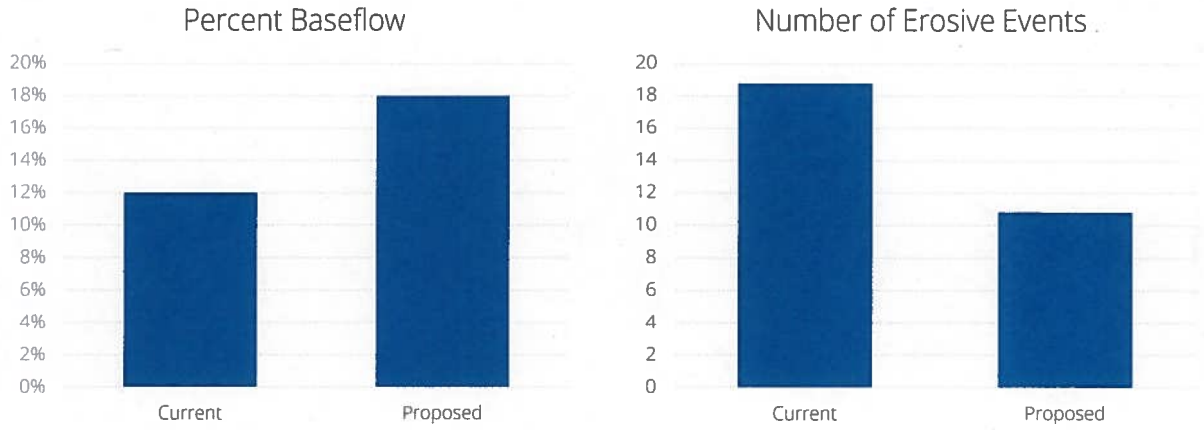


FIGURE 16 *MODELED RESULTS OF THE POTENTIAL EFFECTS OF HIGH (75%) ADOPTION IN RAIN CATCHER PROGRAM ON BASEFLOW (% OF TOTAL FLOW) AND EROSION (FREQUENCY OF EROSIVE EVENTS) IN UPPER WALLER CREEK*

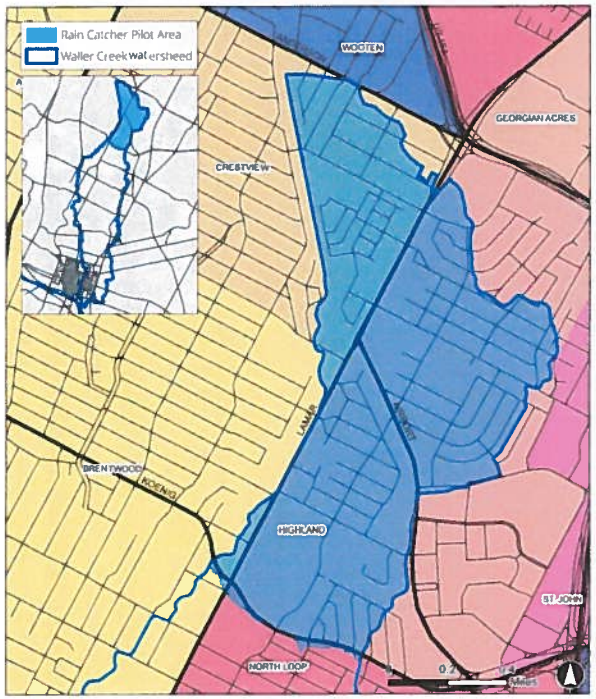


***FIGURE 18** UPPER WALLER CREEK WATERSHED RAIN CATCHER PILOT AREA*

of 25 homes in 2018 to refine and test the incentive program and delivery model. Upon evaluation of the block-scale results, WPD will determine if a suitable trajectory exists to continue expansion of the program into the remainder of the Upper Waller watershed in fiscal years 2019 - 2022.

WPD has allocated $250,000 in fiscal year 2018 for project implementation. WPD and AW are collaborating to determine the best way to coordinate the two utility funding sources via existing rebate programs, with the inclusion of a non-profit partner who will be the primary interface between staff and private participants. In general, WPD plans to increase the incentives available to property owners through the AW rebate programs to cover materials, installation, and inspection of systems. Currently the AW rebate programs provide partial financial reimbursement for the cost of the cisterns and rain gardens only.

Watershed Protection staff are working closely with Austin Water staff and the Integrated Water Resource Planning Community Task Force (Water Forward Task Force), who are developing an integrated water management plan for the next 100 years. This plan includes water supply and demand management portfolios that include on-site and regional stormwater options. This pilot brings together the City goals of decreasing potable water demand for outdoor irrigation, increasing healthy flows in our creeks, and decreasing flooding. Once the Rain Catcher pilot project is concluded in 2022, a report with recommendations for potentially expanding citywide will be presented. It is anticipated that within that time frame, new construction in Austin may be required to have rainwater storage for beneficial indoor and outdoor uses, and that the Rain Catcher program will be primarily used to retrofit the existing development in our more urbanized watersheds.

AUSTIN WATER FORWARD AND THE INTEGRATED WATER RESOURCE TASK FORCE

The Austin Integrated Water Resource Planning Community Task Force (*https://www.austintexas.gov/aiwrpctf*), also known as Water Forward (*http://austintexas.gov/waterforward*), seeks to create a portfolio of water supply augmentation and potable water demand reduction strategies to meet Austin's water needs for the next 100 years while accounting for population growth and a changed climate. Consistent with Imagine Austin priority programs relating to sustainable management of Austin water resources and the use of Green Infrastructure to protect environmentally sensitive areas and integrate nature into the city, Austin Water and Watershed Protection have worked collaboratively throughout the Water Forward process to share information and evaluate solutions that benefit the missions of both utilities.

A diverse suite of water conservation and demand reduction alternatives has been evaluated as part of the Water Forward process, including specific GSI options. GSI options that progressed beyond initial screening and into the rigorous portfolio evaluations include decentralized lot-scale rainwater and stormwater harvesting to meet both outdoor irrigation, indoor non-potable, and indoor potable uses. Centralized community-scale rainwater and stormwater harvesting GSI options are also being evaluated in the portfolio evaluations. The beneficial use of stormwater and rainwater highlights a growing paradigm in which stormwater management may be implemented in a manner that not only reduces flood, erosion, and water quality hazard risk, but also improves water supply resilience to meet the needs of growing urban areas and climatic uncertainty.

Additional GSI options evaluated in Water Forward include landscape management incentives and ordinances to reduce water demands for irrigation that also may maintain or enhance the infiltration of stormwater through pervious surfaces reducing stormwater runoff volumes and improving stormwater runoff quality. The Water Forward final report is scheduled to be submitted to Austin City Council in approximately June 2018. Austin Water and Watershed Protection will continue to collaborate on the implementation phase of Water Forward, including continuing to study and implement GSI.

CODENEXT - GREEN STORMWATER INFRASTRUCTURE PROPOSAL

Evaluate and test the "On-Site Beneficial Reuse" standards using example projects to determine the most appropriate thresholds for application

Current code requires stormwater to be captured and treated, but that water is typically released after 48 hours and sent downstream. The water quality treatment requirements are typically met with sand filter controls, which are effective at filtering polluted runoff and mitigating the impacts of impervious cover on stream channel erosion, but do not significantly address other important ancillary goals such as supporting on-site vegetation, increasing rainwater infiltration, and reducing potable water consumption. In response to the WPD GSI Team's findings and stakeholder input received

through Phase 2 of the Watershed Protection Ordinance and the Green Infrastructure Working Group, City staff are recommending that commercial redevelopment sites be required to use GSI to capture and treat the LDC-required water quality volume

One of the big decisions when implementing this type of requirement is how much stormwater needs to be kept on site (i.e., what size of rainfall event). The desired target for beneficial use requirements is the smaller, more frequent storms rather than the larger flood events. The first draft of CodeNEXT proposed that sites retain the stormwater runoff generated by 95 percent of all rainfall events (known as the 95th percentile rainfall event). Using this standard, the volume required to be retained on-site is a portion of the volume already required to be captured and treated for water quality.

Staff tested the 95th percentile requirement on multiple sites with various soil and impervious cover conditions. This testing used the site characteristics and impervious cover from existing site plans to calculate the amount of stormwater required to be retained onsite and determine which types of water quality controls would be necessary for compliance. The case study testing showed that for areas with poor to intermediate soil infiltration rates, retaining the 95th percentile event could produce complex, costly, and difficult-to-maintain designs. In addition, the designs included hybrid green-grey systems for lower impervious cover sites that were required to retain only a portion of their water quality volume.

Given this outcome, staff modified the recommendation in the CodeNEXT Draft 3 to restructure the beneficial use proposal to require most sites to use GSI to capture and treat the entire water quality volume. Staff believes that the Draft 3 change accomplishes the goals of using stormwater beneficially onsite while minimizing the system complexity, cost, and maintenance impacts. It is anticipated that most developments will propose the use of rain gardens, rainwater harvesting, porous pavement, and retention-irrigation systems (which can be built in conjunction with green roofs). All of these systems beneficially use rainwater to infiltrate and/or offset potable water. Staff also proposes to increase benefits of these controls through improvements to the Environmental Criteria Manual.

Sites over 80% impervious cover will be able to utilize conventional controls (e.g., sand filters) if irrigation demands are met using rainwater harvesting. This provision aligns and integrates with the impervious cover threshold for the **Functional Green** landscape code. Modeling showed that sites over 80% impervious cover were significantly constrained by available space for green controls (e.g., rain gardens) as well as soil infiltration capacity. In addition, modeling showed that even when irrigated at a high rate of one inch per week, the rainwater harvesting system could supply at least half of the annual water demand to the irrigated area.

If adopted, there are provisions in Draft 3 that allow exceptions from the GSI requirement and allow conventional controls to be used for regional ponds, difficult site conditions, and "hot-spot" land uses with highly contaminated runoff (e.g., auto repair facilities). The code will also allow conventional controls for single-family residential subdivisions due to potentially higher initial and ongoing maintenance costs for some GSI applications compared to more traditional methods (e.g., complex plantings, pumps, etc.). Staff recognizes both the promise and challenge of using GSI approaches in single-family developments due to the "distributed" nature of these controls: they are dispersed over a large number of parcels rather than concentrated in one or a few central areas. This is both a strength and a weakness of GSI: the benefits are widespread, but this greatly complicates questions of ownership, maintenance, inspection, and longevity. Staff will continue to evaluate possible approaches to use GSI in these settings, but does not recommend a change with CodeNEXT. In the meantime, applicants will still have the option to use GSI for single-family subdivisions in the form of rain gardens for four or more lots. This approach offers the benefits of more decentralized controls while still facilitating inspection and maintenance.

Determine the cost implications to the property owner of applying this tool to residential including both new development and remodels

CodeNEXT is not proposing to require green stormwater infrastructure for residential subdivisions or the construction or remodeling of individual residential units (see above). The requirement to provide green stormwater infrastructure will apply to site plan projects proposing greater than 8,000 square feet of impervious cover.

Table 3 summarizes research on local capital costs for rainwater harvesting and rain gardens based on standard options for sizing and materials:

***TABLE 3** AVERAGE CAPITAL COSTS FOR RAINWATER HARVESTING AND RAIN GARDENS*

Rainwater Harvesting	Average Capital Costs
1,000 gallons	$3,000 (passive), $5,700 (pressurized)
1,500 gallons	$3,500 (passive), $6,200 (pressurized)
2,500 gallons	$4,000 (passive), $6,700 (pressurized)

Rain Garden	Average Capital Cost
300 gallons	$2,700
500 gallons	$3,200

CONCLUSIONS

The next frontier for GSI in Austin entails the codification of Water Forward recommendations, particularly the lot-scale rainwater harvesting options. Integrating rainwater harvesting into the water supply plumbing infrastructure will spur increased beneficial use while addressing concerns regarding inspection and maintenance on decentralized GSI applications.

Integrated Green Infrastructure Plan: Proposed Framework

City Council approved a resolution (No. 20170615-071) last June directing staff to "assess the City's progress toward achieving the vision, goals, policies, and actions relating to green infrastructure, as defined in the Imagine Austin Comprehensive Plan[1] and to identify and evaluate opportunities and strategies to further integrate and leverage the City's green infrastructure related programs and projects." The purpose of this document is to outline a proposed framework for the completion of this task through the development of an Integrated Green Infrastructure Plan, including a discussion of the process, timeline, and required resources.

Using green infrastructure to protect environmentally sensitive areas and integrate nature into the city is one of Imagine Austin's key priority programs. The program is implemented by multiple city departments and other community partners. Progress is tracked and reported on a regular basis by the Imagine Austin Green Infrastructure Priority Program Implementation Team.

The Integrated Green Infrastructure Plan will be coordinated by the Watershed Protection Department and will be developed as detailed below using existing staff resources. In anticipation of this effort, department directors have assigned technical leads for each general category of green infrastructure. Staff will also leverage the work already completed for existing plans and programs related to green infrastructure, including the Parks Long-Range Master Plan, the Urban Forest Plan, the Urban Trails Master Plan, the State of the Food System Report, and the Watershed Protection Master Plan.

Phase 1: Green Infrastructure Web Portal
Spring/Summer 2018

Staff proposes to organize and display the Integrated Green Infrastructure Plan as a dynamic web portal that will introduce the concept of green infrastructure and serve as a streamlined, user-friendly gateway to online city data and resources. The portal will utilize the ArcGIS Online Story Map tool and will be an extension of the existing Imagine Austin website. Content from the web portal can also be summarized in a short handout or brochure for printing as necessary. Creation of the web portal will implement the short-term work program[2] outlined in Imagine Austin by providing the following components:

- An overview of Austin's green infrastructure, its elements, and how those elements interact to benefit the community.
- A summary of ecosystem services provided by green infrastructure, including a discussion of the asset value of those services and their contribution to long-term risk management.
- A summary of reports and case studies examining the direct and indirect costs and savings from green infrastructure projects, when compared with traditional "gray" infrastructure.
- An inventory of the community's existing green infrastructure assets, including the urban forest, parks, wildlands, water resources, trails, and urban agriculture.
- A series of interactive maps illustrating the components of the green infrastructure network, along with priority areas for restoring and/or expanding the city's green infrastructure network.
- An inventory of existing implementation strategies relating to green infrastructure, including plans, reports, policies, programs, and projects.

- A summary of land management activities and practices for public lands, including a discussion of how these green infrastructure maintenance and support services are coordinated across multiple City departments.
- A summary of green infrastructure targets and metrics, including resources and information available on the city's open data website.

Phase 2: Gap Analysis and Needs Assessment
Fall 2018

Staff will perform a gap analysis and needs assessment for the city's existing green infrastructure implementation strategies and issue a report that will:

- Assess critical gaps and challenges related to green infrastructure policies and priorities.
- Identify potential conflicts between existing policies and priorities.
- Identify and evaluate opportunities to further integrate and leverage programs.
- Recommend solutions to address identified gaps, challenges, and opportunities.

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[1] Imagine Austin defines green infrastructure as an interconnected system of parks, waterways, open space, trails, green streets, tree canopy, agriculture, and stormwater management features that mimic natural hydrology.

[2] Create an integrated green infrastructure plan and ongoing green infrastructure program. The plan should:

a. Define Austin's green infrastructure, its elements, and how those elements interact to benefit the city.
b. Perform an initial inventory and evaluation of existing green infrastructure resources, such as conserved land, the urban forest, habitat, trails and bike paths, greenbelts, community gardens, urban farms, parks and recreation areas, and green streets.
c. Identify current plans, such as the Travis and Hays County Greenprint plans, networks, and identify gaps.
d. Develop green infrastructure targets (such as percentage of tree cover, connectivity, or current or anticipated residents within walking distance of parks, see Figure 4.11) and priorities for new areas for conservation, parks and open space, green streets, and urban trails.
e. Include a series of interactive maps illustrating the components of the green infrastructure network, along with priority conservation and restoration areas.
f. Include implementation strategies and approaches to promote interdepartmental, intergovernmental, and interagency coordination.
g. Calculate direct and indirect costs and savings from green infrastructure projects, when compared with traditional "gray" infrastructure, including the asset value of ecosystem services and contribution to long-term risk management.
h. Develop and implement unified, comprehensive land management of all City of Austin lands for integrated environmental sustainability, including carbon sequestration, wildlife habitat, water quality and quantity, and education.